



Prediction of height of the Ibibio ethnic group of Nigeria using foot size

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This present study was to determine the stature and foot length and to determine the correlation if any between stature and foot length among adults of the Ibibio ethnic group of Nigeria. It was also aimed to find a regression equation to predict stature from foot length in adults of the Ibibio ethnic group of Nigeria. Adults of the Ibibio ethnic group participated in this anthropometric study. A total of 300 people (179 males and 121 females) between the ages of 18 and above were studied. These participants were randomly selected from the eleven local government areas of Akwa Ibom state which make up the Ibibio ethnic group. Verbal consent was obtained from each individual. Stature and foot length were measured using standard anthropometric techniques. Pearson's coefficients of correlation and regression equations were calculated using Minitab statistical package for stature and foot length. The mean and standard deviation for stature in this study was 167.45 ± 7.03 and 159.89 ± 5.44 for male and female respectively and that for foot length was 27.01 ± 3.143 and 25.31 ± 1.20 for male and female respectively. The foot length showed a strong significant linear correlation (r) with stature. ($r=0.71$ and $r=0.64$, ($p<0.01$) for males and females respectively. The following equations were derived to predict the stature (S). In males $S = 74.37 + 3.45$ foot length (cm), in females $S = 86.36 + 2.91$ foot length (cm). The results from this study showed that the male had significantly higher figures in all parameters than their female counterpart, thus indicating the existence of sexual dimorphism in these parameters among the Ibibio ethnic group of Nigeria. The result from this study is comparable to studies done in other ethnic groups and may be relevant in further anthropometric or forensic studies as it concerns the Ibibio ethnic group.

INTRODUCTION

Anthropometry is a branch of Physical Anthropology that deals with the systematized measurements of the external dimensions of the human body and skeleton [1]. Anthropometry is often viewed as the basic tool of Physical Anthropology, but it has found wide application in Forensic and Medical Sciences especially Surgery. No two individuals are exactly alike in all their measurable traits, and these undergo changes to varying degrees from birth to death, and in health and disease [1]. Since skeletal development is influenced by a number of factors producing differences in skeletal proportions between people from different geographical areas, it is desirable to have some means of giving quantitative expression to variations which such traits exhibit [2]. Inter and intra population variations may be observed in relation to anthropometry due to factors such as genetic makeup, age, gender and ethnicity [3]. The ultimate aim of using anthropometry is to help in achieving personal identity in case of unknown human remains [4]. Today, anthropometry plays an important role in industrial design, clothing design, ergonomics and architecture where statistical data about the distribution of body dimensions in the population are used to optimize products [4]. Changes in lifestyles, nutrition, and ethnic composition of populations lead to changes in the distribution of body dimensions (e.g. obesity epidemic) and require regular updating of anthropometric data collections [4, 19-

22]. Anthropometry is a branch of Physical Anthropology that deals with the systematized measurements of the external dimensions of the human body and skeleton [1]. Anthropometry is often viewed as the basic tool of Physical Anthropology, but it has found wide application in Forensic and Medical Sciences especially Surgery. No two individuals are exactly alike in all their measurable traits, and these undergo changes to varying degrees from birth to death, and in health and disease [1, 23]. The Ibibio people occupy the palm belt in the southeast Nigeria, and are regarded as the most ancient of all the ethnic groups in Nigeria. According to Robert McKeon, the Ibibio are probably the indigenous natives from whom most small tribes of Akwa Ibom and Calabar are descended. The early settlement of the Ibibio in the area led to the development of a number of sub-clans, notably the Annang, the Efik, and the Oron.

RESEARCH METHODOLOGY

The study was carried out between May 2018 to August 2018 on Three hundred (300) Ibibio adults (179 males, 121 females) between the age range of 18 to 50. Male and female subjects were selected at random from Itu, Uruan, Uyo, Etinan, Ikono, Ibiono, Nsit Ibom, Nsit Ubium, Ibesikpo Asutan, Ini, Mkpa Enin Local Government areas. The slovens formula was used to calculate the minimum sample size of subject in this research.

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Figure 1 Measurement of Height. Photograph taken from the subject



Figure 2 Measurement of Foot Length. Photograph taken from the subject

$$n = N/1+N(e)^2$$

n=Sample size, N=Population size (Ibibio-4,500,000. Federal Republic of Nigeria official gazette, 2006), e=Significant level (0.01)

Sample size for Ibibio $n=4,500,000/1+4,500,000(0.01)^2$

Minimum sample size for Ibibio = 299.7 approximately 300 subjects were used.

Materials

Measuring Tape, Ruler, Marker pen, Note book, Data collection forms

Measurement of Stature

The subjects were made to stand in an upright position with both hands on the sides facing a plain surface (mostly wall). The ruler was placed on top of the subjects (the persons) vertex to indicate the upper margin and this point was marked on the wall using a marker pen, then the height of each individual was measured using a steel meter rule. The distance between the vertex and the floor is the height recorded in centimeters (cm).

Measurement of Foot Length

The subjects were made to place their foot on a white plane sheet. A meter rule was used to measure the foot length from the tip of the great toe to the heel of the foot.

Inclusion Criteria

The following were the inclusion criteria for this study;

- 1.The subjects were selected from the eleven LGAs that make up the Ibibio ethnic group.
- 2.The subjects were indigenes of Ibibio ethnic group and had dual parentage; their parents and grandparents where from Ibibio ethnic group.
- 3.The subjects included male and female of 18 and above.

Exclusion Criteria

The following were the exclusion criteria for this study;

- 1.Individuals with recognized deformities of leg, thigh or foot were exempted from the study.
- 2.Subjects with just one parentage of the Ibibio ethnic group were excluded
- 3.Subjects below 18 years were excluded from the study.

Precautions

The following precautions were taken during the measurement:

- 1.Measurements were taken on bare foot.
- 2.Each participant's measurements were taken twice to obtain accurate results.
- 3.Subjects used were adults from 18 years and above.
- 4.Verbal consent was obtained to confirm subjects' parentage to be of the Ibibio ethnic group.

Statistical Analysis

Pearson's coefficients of correlation and regression equations were calculated using Minitab statistical package between stature and foot length. A regression analysis was carried out to predict the stature (height) of the males and females from their foot length at significance level of 0.01.

RESULTS

The result of the mean and standard deviation of height (stature) and foot length of the Ibibio ethnic group are shown in the tables below. Table 1 shows the mean and standard error of female stature and foot length while Table 2 shows the correlation between female stature and foot length at 0.01 level of significance and correlation coefficient of 0.64. Table 3 shows the mean and standard error of male stature and foot length, while Table 4 shows the correlation between male stature and foot length at 0.01 level of significance and correlation coefficient of 0.71. Table 5 and 6 shows the mean and standard deviation of male and female height and foot length. The mean and standard deviation of height of the males and females were 167.45 ± 7.03 cm and 159.89 ± 5.44 cm respectively. It was observed that the Ibibio males had a significantly higher height than the Ibibio females ($p < 0.01$). The mean and standard deviation of foot length of the males and females were 27.01 ± 1.43 cm and 25.31 ± 1.20 cm respectively. It was observed that the males of the Ibibio ethnic group had a significantly larger foot length than their female counterpart ($p < 0.01$). It was also observed that the foot length of Ibibio ethnic group was significantly lower than the height of the Ibibio people. Using the mean and standard deviation of the foot length of Ibibio male and female, height can be predicted, i.e, the higher the foot length the higher the height. Table 7 shows a comparison of the mean foot length of present study and previous studies. It was observed that, there were ethnic differences in these parameters. Table 8 shows the Linear Regression Equation for estimation of Stature (Height) from foot length. Figure 3 is a scattered graph showing the correlation between female stature and foot length and Figure 4 is a scattered graph showing the correlation between male stature and foot length.

Correlation coefficient for female $R = 0.642$.

Regression Linear Equation of Female for Stature from Foot Length

Ibibio female Stature = $86.358 + 2.905$ Ibibio female Foot Length (cm).

A Scatterplot showing the Correlation between Female and Stature and Foot Length.

Correlation coefficient of Male $R = 0.706$

Regression Linear Equation of Male for Stature from Foot Length

Ibibio Male Stature = $74.365 + 3.446$ Ibibio Male Foot Length (cm). A

Scatter plot showing the Correlation between Male Stature and Foot Length.

DISCUSSION

When the accurate measurement for stature is unobtainable, it is computed using other surrogates. Foot length is one of the most widely used [5]. This study analyses the correlation coefficients of stature and foot length of the Ibibio ethnic group of Nigeria among adults of 18-50 years. Regression equations are hence developed to predict stature. The major determinants of one's height are the length of the bones and the height of the vertebral column [5]. At the time of fusion of long bones and completion of growth of the vertebral column the maximum stature is achieved. This skeletal growth stops at the age of 18 to 20 years [5]. After achieving maximum stature the bones are in relatively static period up to 40 years of age after which the natural process of senile degeneration takes place [6]. Some researchers have stated that there may be certain degree of independence between age and foot length [7]. It is observed that the males generally have higher anthropometric

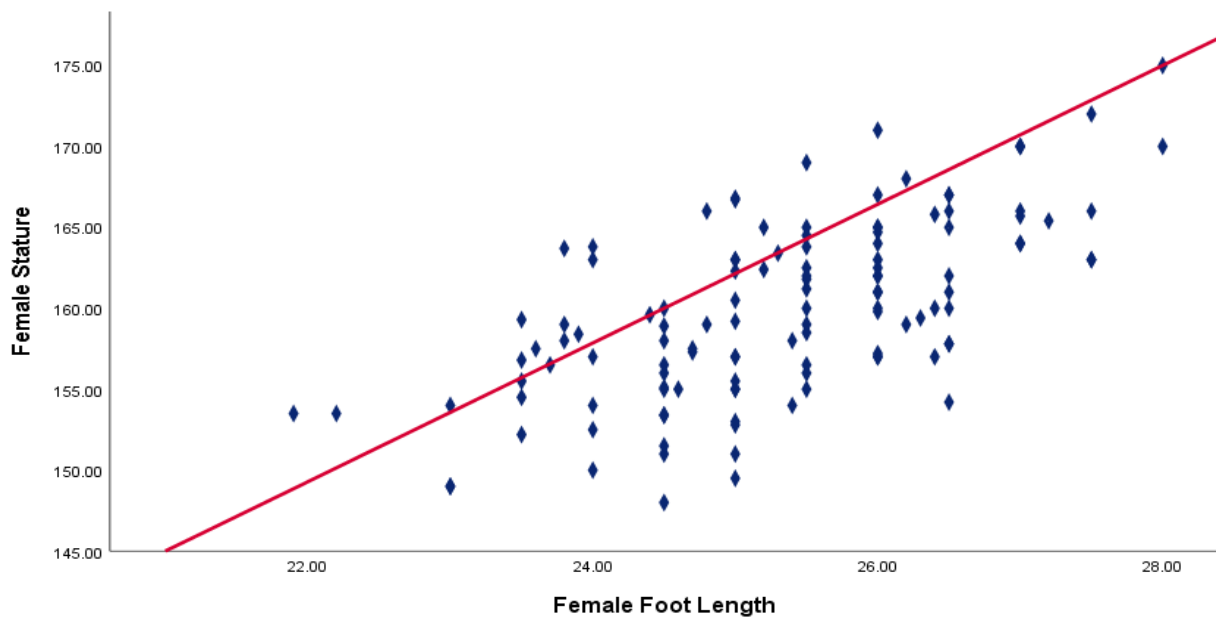
Table 1 Mean and Standard Error of Female Stature and Foot Length

	N	Minimum	Maximum	Mean±Std. Error
FEMALE STATURE	121	148.00	175.00	159.89±0.49
FEMALE FOOT LENGTH	121	21.90	28.00	25.31 ± 0.10

Table 2 Correlations between Female Stature and Foot Length

		Female stature	Female foot length
FEMALE STATURE	Pearson Correlation	1	0.642**
	Sig.		0.000
	N	121	121
FEMALE FOOT LENGTH	Pearson Correlation	0.642**	1
	Sig.	0.000	
	N	121	121

** Correlation is significant at the 0.01 level

**Figure 3** Pearson correlation of Stature (cm) and Foot Length (cm) for the Ibibio female. R = 0.642**Table 3** Table showing the mean and standard error of male stature and height

	N	Minimum	Maximum	Mean ± Standard Error
STATURE	179	148.50	190.00	167.45 ± 0.52
FOOTLENGTH	179	23.00	31.00	27.01 ± 0.10

Table 4 Correlations between male stature and foot length

		STATURE	FOOT LENGTH
STATURE	Pearson Correlation	1	0.706**
	Sig.		0.000
	N	179	179
FOOTLENGTH	Pearson Correlation	0.706**	1
	Sig.	0.000	
	N	179	179

** . Correlation is significant at the 0.01 level

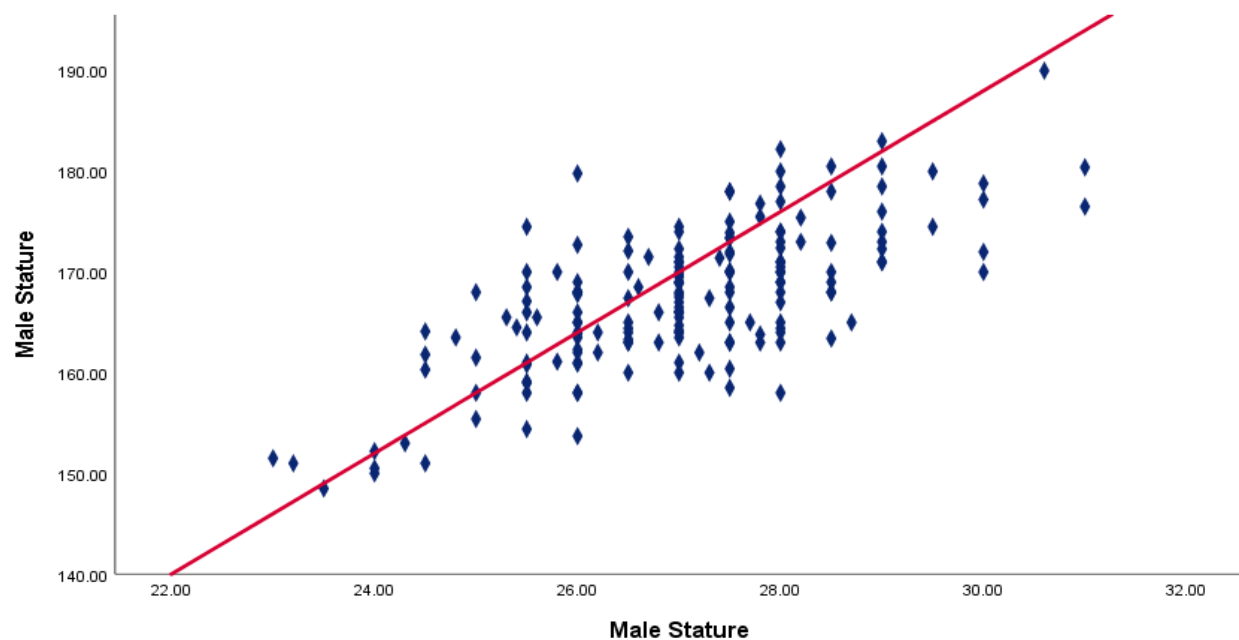


Figure 4 Pearson correlation of Stature (cm) and Foot Length (cm) for the Ibibio male. $R = 0.706$

Table 5 Showing mean and standard deviation values of measured parameters for the Ibibio ethnic group

Parameters	Sample Size (N)	Males (N=179)	Females (N=121)
Stature (cm)	300	167.45±7.03	159.89±5.44
Foot height (cm)	300	27.01±1.43	25.31±1.20

$P < 0.01$

Table 6: Showing mean values of measured minimum and maximum parameters for the Ibibio ethnic group

Parameters Count	Mean	SD. Minimum	SD. Maximum	SD.
Female Height (Cm)	121 159.89	148.00	175.00	5.44
Female foot length(cm)	121 25.31	21.90	28.00	1.20
Male Height (Cm)	179 165.45	148.51	90.00	7.03
Male foot length	179 27.01	23.00	31.00	1.43

SD.: Standard Deviation

Table 7 Showing a comparison of mean foot length of present study and related studies

Researchers (year)	Ethnic group	Males(cm)	Females(cm)
Fawehinmi and Paul (2008)	Igbo	53.30±3.30	51.75±2.78
	Hausa	58.03±2.37	55.25±2.37
Binoy and Kaushik(2015)	Bengalese	50.49±2.54	45.20±2.33
Stellenbosh University	Adult group	53.05± 0.7	49.44± 2.57
	Older group	52.70± 3.04	49.39±2.86
Li <i>et al</i> (2000)	Chinese	48.4 ± 1.9	45.7 ± 1.9
Aline <i>et al</i> (2015)	Brazil	51.6 ±2.7	47.3±2.5
Shahar and Pooy (2003)	Malaysia		
	Adult group	49.80 ± 2.50	49.80 ± 2.50
	Elderly group	46.10 ± 2.30	49.20 ± 2.20
Kyoung <i>et al</i> (2009)	Korea	50.50±2.50	47.40±2.00(PRM) 46.00±2.10(POM)
Dominica (2017)	Annang	53.60±3.34	51.441±3.49
Pradeep <i>et al</i> (2001)	Mumbai	6.70+0.61	6.69+043
Present study	Ibibio	27.01±1.43	25.31±1.20

PRM: Premenopausal

POM: Postmenopausal

Table 8 Table showing the regression Equation of male and female stature and foot length in Ibibio ethnic group

Variable	Regression Equation	Corr. Equation
Ibibio Males Foot length (cm)	Ibibio Males Height (Stature) = $73.10 + 1.72$ Ibibio Male foot length(cm)	0.71
Ibibio Females foot length (cm)	Ibibio Females Height (Stature) = $107.00 + 1.04$ Ibibio female foot length (cm)	0.64

measurement than that of females in the present study. Similar observations are made in many studies [8], [9] and [10]. These differences may be due to gender associated genetic factors, hormonal factors and lifestyle factors [8], [9] and [10]. Mean stature for population of adults varies from minimum values for the Efe pygmies of Africa at 144.9cm for men and 136.1cm for women [11] to the maximum values for the Dutch of Europe at 184.0cm for men and 170.6cm for women [12].

According to the study by Dr. Chao, height is said to be affected by genetics, environment and nutrition. It has been reported that the most important nutrient for one to reach his or her maximum height potential is protein in childhood and also food rich in calcium, vitamin A and D are essential for a child's growth [13]. This however explains the reason for tall height among the Dutchs whose meals are known to be rich in protein. This phenomenon may also explain the relatively short stature of the Ibibio people because their major food is carbohydrate from cassava and maize [14].

The required sample size to develop prediction equations depends on the number of independent variables and their relation with the dependent variable [15]. In this study, the sample sizes are population-based and large enough to estimate accurately the height in Ibibio adults. The equations reported herein were obtained from large representative samples from the selected villages, thereby allowing for the possibility of their application to the Ibibio ethnic group of Nigeria.

It is observed that the males generally have higher anthropometric measurement than that of females in the present study. Similar observations are made in many studies including Li *et al.*, 2000 [10], Fatmah and Chumlea *et al.*, 2009 [9].

In this present study, foot length showed a strong positive linear relationship with height in males and in females. This corresponds with the study of Patel *et al.*, 2007 [16] which showed a positive correlation of foot length with height to be $r = 0.61$ and 0.43 for male and female respectively among Peradeniya medical students. Fatmah, 2009 [8] also obtained a similar result on his study on Indonesian Javanese elderly people with a correlation coefficient of knee height to stature of ($r = 0.698$) and ($r = 0.679$) for male and female respectively. Li *et al.*, 2000 [10] obtained a similar result on his study among Chinese elderly people, the correlation coefficient was 0.633 for male and 0.665 for female at ($P < 0.001$).

Binoy and Kaushik's work on the older Bengalees of Purba Medinipur, West Bengal, India to predict height from knee height showed a similar result with the Pearson's correlation coefficient (r) being 0.724 ($p < 0.001$) for men and 0.534 ($p < 0.001$) for women also showed a strong positive correlation [17].

Similar correlations as shown in the present study too makes it clearly evident that the foot length can be used as the predictor of stature, but it should be borne in mind that ethnic specific equations should be derived for a specific ethnicity [17]. Fawehinmi and Paul's work on the Igbos and Hausas where Igbos had a mean and standard deviation of the knee height to be 53.30 ± 3.30 and 51.75 ± 2.78 for male

and female respectively and for the Hausa's was 58.03 ± 2.37 and 55.25 ± 2.37 for male and female respectively was similar to the mean and standard deviation for knee height in this present study. While Li *et al.*, 2000 [10], Shaharet *et al.*, 2000 [18] showed a better correlation between these parameters in their studies. This contradiction may be mainly due to the variations in mean ages of above study groups, and subsequently to ethnicity of study groups and other environment based factors of growth.

CONCLUSION

The research was conducted to determine the stature and foot length of the Ibibio ethnic group and to derive a correlative equation that could be used to predict stature using foot length among adult Ibibio individuals. This study was imperative because there had been no work done to predict stature using foot length among the Ibibio ethnic group. Results obtained from this study showed that foot length has a strong positive correlation with stature among the Ibibio adults. This study therefore suggests that foot length could also be used in determining stature among other ethnic groups.

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Competing Interests

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